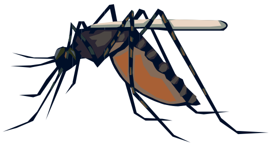
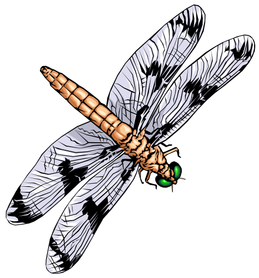
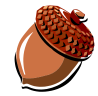


Water Canaries





In a Nutshell

Through collection, identification and counting of aquatic invertebrates, students will discover that life underwater provides scientists with clues to the health of a wetland.

Grades *3, 4 & 5*
Seasons Spring, Summer
Location Bass Ponds Trailhead, Long Meadow Lake Unit

Learning Objectives

After participating in this activity, students will be able to:

- Define the term macro-invertebrate.
- Explain how the presence or absence of aquatic insects may be an indicator of wetland health.
- Name at least one macro-invertebrate that has low tolerance to pollution.
- Name at least one macro-invertebrate that has a high tolerance to pollution.
- Explain how pollution tolerance of a macro-invertebrate is influenced by breathing design.

Literature Connections

Waterman's Boy by Susan Sharpe (720L)
Golden Guide to Pond Life by George K. Reid
One Small Square: Pond by Donald M. Silver
Trout are Made of Trees by April Pulley Sayre (AD450)

Pre-Activities

Project WET *Macroinvertebrate Mayhem* *(upper elementary)*
Students learn how different water organisms tolerate changes in water quality. Participating in a game of tag, students discover that

the presence of certain species, along with diversity, can be an indicator of water quality.

On-site Activities

Students use aquatic insect dip nets and microscopes to observe and catch macroinvertebrates in a refuge wetland. Using field guides and a Biotic Index, they assess the "health" of the wetland based on the types and population of macroinvertebrates they discover.

Classroom Connection

Analyze your Refuge Data

Have students analyze the data students collected during the refuge fieldtrip using these or similar methods.

- Create a bar graph or pie chart comparing the numbers of macroinvertebrate species collected. Rank the species in order of highest to lowest number of individuals caught.

- Divide the macroinvertebrates caught into each of the following pollution index categories: High Tolerance, Mid Tolerance, and Low Tolerance. What percentage of the total catch was represented in each category?

- Analyze the percentage for each species of the total collected. Ask students which type of macroinvertebrate represented the largest portion of the sample?

Project WILD Aquatic activity, *What's In the Water* *(upper elementary)*

Students learn to identify major sources of water pollution and then consider the potential effects water pollution may have on a variety of wildlife.

Calculate a Water Quality Score

Compile each team's fieldtrip data from the Macroinvertebrate Survey form, into a class total. Pass out the attached Creek Critter Connection: Macroinvertebrate Tally. Ask students to calculate a water quality score for the refuge pond surveyed, using the step-by-step calculations from the worksheet.

Teacher Resources

Watersheds: A Practical Handbook for Healthy Water by Clive Dobson
Wonderful Wacky Water Critters, Wisconsin Department of Natural Resources, Extension Publication GWQ023
Guide to Aquatic Insects and Crustaceans, Izack Walton League

Water Canaries
Pre-Visit Activities

Materials

- Macroinvertebrate Mayhem Kit:
  lanyards/cards (dragonfly nymph, caddisfly larva, damselfly nymph, stonefly larva, mayfly larva, rat-tail maggot, midge larva, and environmental stressor), 3 Pillow cases
- Game instructions
- Chart paper or dry erase board
- Markers
- Pollution Index of Common Marsh Invertebrates laminated charts
- Poster- America's Aquatic Insects: Indicators of Stream Health

Introduction

Start with a discussion of aquatic invertebrate characteristics. If the class has participated in *Pond Insects* or *Wetland Safari* curriculum fieldtrips ask them to name what aquatic invertebrates caught. Use the chart and the poster to refresh their memories.

If the class has never dip netted any water system (pond, stream, lake) for aquatic invertebrates, identify clarify the term. An aquatic invertebrate is an animal that has no spine (backbone) and needs water in order to live. Discuss what organisms they are likely to find using the chart and poster to illustrate.

Shift the discussion into the 3 ways aquatic invertebrates' breath: Taking in dissolved oxygen carried in the water, taking in oxygen from the air, and absorbing oxygen through their skin.

- Some aquatic invertebrates, such as tadpoles, start their life with gills. Gill breathers absorb oxygen that is dissolved in the water. This group of animals is generally intolerant of water pollution. These low tolerance invertebrates include mayflies, stoneflies, caddisflies and gill-breathing snails.
- Air breathing invertebrates have two breathing methods. An air tube, functioning something like a snorkel, extends from their

bodies and stick out above the water. Invertebrates with air tubes include mosquitoes, blackfly larvae, and water scorpions. Other air breathers carry an air bubble on their body. These invertebrates come to the surface, grab a bubble of air, and then dive underwater. Once the air bubble is used up, they return to the surface to grab another bubble of air. Water boatman and diving beetles are air bubble breathers. Since air breathers do not depend on water for their oxygen, they are generally tolerant of many types of water pollution.

- Animals that absorb oxygen through their skin include aquatic worms, leeches, some snails, and most amphibians (frogs, toads, and salamanders).

Game

Follow part II of the Project WET activity, *Macroinvertebrate Mayhem*, found on page 322 of the Project WET curriculum. It is best to conduct this activity where there is plenty of open space to move, either outside or in a gym.

1. Explain to students that they will play a game to understand how pollution changes the population of macroinvertebrates in an aquatic habitat.
2. Ask for a volunteer to represent a type of pollution (for example, fertilizer, sewage, oil). Discuss with the class ways that this material may enter a natural body of water.
3. Divide the rest of the class into seven groups. Each group will represent one type of macroinvertebrate. Record the number of members for each group on a flip chart as illustrated below.

Organism	*Tolerance*	*Numbers (At Start and After Each Round)*			
		Start	Round 1	Round 2	Round 3
Caddisfly larvae	Intolerant	5	2	2	2
Mayfly larvae	Intolerant	5	4	1	0
Stonefly larvae	Intolerant	4	4	4	2
Dragonfly larvae	Facultative	5	5	4	4
Damselfly larvae	Facultative	4	4	4	3
Midge larvae	Tolerant	4	6	7	9
Red-tailed maggot	Tolerant	4	6	9	11
Total		31	31	31	31

4. Pass out each macroinvertebrate “necklace” to students. Be sure the picture of the macroinvertebrate faces outward.
5. Players that represent organisms intolerant to pollutants will have a harder time moving across the field (representing the wetland). Have students practice their motions before starting the game.
   - Caddisflies must hop across the field, stopping to gasp for breath every five hops.
   - Stoneflies must do a jumping jack every ten steps.
   - Mayflies must flap arms and spin in circles as they cross the playing field.
6. Move all the students representing macroinvertebrates at one end of the playing field. Students that represent the environmental pollutants should space themselves along the mid-line of the playing area.
7. At the signal of a round, students wearing macroinvertebrate necklaces must move to one end of the playing area. To survive, the students must reach the opposite end without being tagged by a student that represents an environmental pollutant.
8. Tagged macroinvertebrates must go to the sideline. The round ends when all of the students have been tagged or have reached the opposite end of the playing area.
9. Instruct students on the sideline, those that did not survive the round, to flip their identification label to display the more tolerant species they now represent. They will become either a rat-tailed maggot or midge larvae for the next round. Record this new numbers of members in each species.
10. All students representing the macroinvertebrates should re-gather at the starting end of the playing area. Complete two more rounds. Record the new numbers of members for each species at the start of each round. Because some layers will have flipped their identification “necklaces” there will be a larger number of tolerant species in each successive round.
11. Discuss the outcome with the students. How did the population sizes of groups change from the beginning of the game? What were some possible reasons for the population changes? Why are some organisms more tolerant of pollution than others?

Wrap Up

Explain to students that during their refuge fieldtrip they will be sampling a wetland for aquatic invertebrates. They will identify their catch and determine the general health of the wetland.

Remind students to wear old clothes in case they get wet or dirty. Jeans and close-toed shoes like sneakers are best for this field trip. Shorts and flip flops are not appropriate. Encourage students to apply sunscreen and insect repellant if they choose BEFORE traveling to the refuge.

Water Canaries
On-site Activities

Materials

- Aquatic Investigation Kits-per student team of 2 or 3 that include: 1 long-handled aquatic net, 1 dip nets, 4 specimen collection containers, 2 plastic spoons, laminated key to aquatic organisms, 2 magnifying glasses.
- Dry Table(s): 2 Folding tables for microscopes, petri dishes, well slides, droppers, paper towels, specimen observation dishes or white ice-cube trays, field guide / reference book.
- Jug of tap water
- Jug of pond water
- 2 clear glasses
- Poster-sized, laminated Water Quality Index Pond Data Sheet
- Water Canaries Journal Page – one per student
- Clipboards- 1 per student
- Pencils- 1 per student
- Calculators – 1 per team
- Markers

<u>At the conclusion of the lesson</u>: Return live specimens to the wetland areas where they were collected (if there is time, it is best to have students participate at the conclusion of their session). Be sure all microscopes and slide preparation materials are clean, dry and covered before storing. Thoroughly rinse equipment and leave out to dry in the visitor center classroom. Please inventory and note any low quantities of supplies or broken equipment.

Introduction

*(*15 minutes, if not sampling at the Bass Ponds Trailhead, do not discuss.)*
*Briefly discuss with students the history of the Bass Ponds site and the purpose wetlands serve today. In the early 1900s, the Bass Ponds site was a fish hatchery for large mouth bass. The Fish and Wildlife Service purchased the property in 1976 when the fish hatchery was no longer in

operation and the land had been excavated. The refuge restored the ponds to their original condition. Today, the ponds are used for storm water filtration. Explain to students that this is a sensitive ecological area. Excessive trampling or inappropriate behavior creates damage. When visiting a National Wildlife Refuge, always remember *wildlife comes first.*

Hike down to the wetlands. Have students gather around you, making sure not to touch the equipment and ask the following questions.

1. How is a biologist able to tell if a body of water is "healthy?"
2. Do you think biologists are able to tell if it is healthy just by looking at the body of water?
3. Pour the tap water (brought along in a jug) into a glass. Hold the glass up to show students the tap water. Ask students if they would feel comfortable drinking this water.
4. Fill a glass with pond water. Ask students if they would feel comfortable drinking this water. Which of the two types of water would be "healthier" for a minnow or insect larvae?

Explain to students the terms "clean" and "healthy" have different meanings. Pond water may not be fit for humans to drink; however, many of the small organisms seen floating in the water may be food for a multitude of other creatures living in the water. Most pond life would die if left too long in sterile drinking water.

Poisons and fertilizers may be invisible to the human eye when suspended in the water. By observing the life in the pond, biologists can look for signs of contamination. For example, fertilizers will increase the amount of plant life found in the water. Some types of algae "blooms" are signs of fertilizer runoff. Poisons can sicken or even kill fish, and the animals that feed on fish.

A common and inexpensive field sampling method biologists use to determine water quality is to sample species of plants and animals present. Biologists can determine if a water system is "healthy" or "unhealthy" based on what they find living in the water.

A macro invertebrate sample is a collection of aquatic animals that do not have an internal skeleton, but are large enough to see without a microscope. Macroinvertebrates are often referred to as biotic indicators because they can only survive conditions within their range of tolerance. Some macroinvertebrates (such as the Caddisfly larvae) have a narrow range of tolerance and will be found only in water free of any type of pollution. Other macroinvertebrates (such as leeches, midges and air breathing snails) have a wide range of tolerance and can live with almost any water conditions.

Collecting specimens

(30 minutes)

Select an area appropriate for dip netting – assuring the site is safe for students, can accommodate the group and will not suffer extreme environmental damage.

Explain to students this is a sensitive ecological area. Excessive trampling or inappropriate behavior can damage this sensitive ecological area. When visiting a National Wildlife Refuge, always remember *wildlife comes first*. Make it clear to students that plants and animals are protected and must be returned unharmed to the wetland at the conclusion of the activity.

Divide the class into teams of no more than 4 per group. Demonstrate for students the proper way to use the sampling equipment and how to transfer specimens gently to the buckets of clear water for observation. Allow students 20-30 minutes, and then shift their focus from collection to observation. Collect all the nets and pass out the identification sheets and field guides.

Students may be hesitant to touch the creatures they have netted and may use plastic spoons. Keep in mind, students will be more encouraged if you show them how to safely handle animals and stand by to provide guidance while students try it themselves. Touching some of the organisms collected may actually help build a students sense of trust and a sense of connection to other living things.

Sorting and Identification

(30 minutes)

Ask all teams to work together to sort the animals into similar groups. For example, sort all the dragonfly larvae into one container, all leeches in another and so on. Once the sorting is complete, pass out a journal page, clipboard and pencil to each student. Ask them record the number (used only the data analysis component of this activity) and type of macro-invertebrates they found. Place all containers on one table and give students some time to compare results between groups.

Bring out the laminated, poster-sized *Water Quality Index* datasheet and pass out 2 calculators to each team. Work through the data sheet as an entire class, collecting information from each team. Complete the calculations by following the directions at the top of the sheet. Ask students to use the calculators to help determine the water quality score.

Wrap-up Management Connection

Using a Biotic Index to Predict Water Quality

(15 minutes)

Macroinvertebrates have a range of physical and chemical conditions in which they can survive. Some thrive in a wide range of conditions and are more tolerant to pollution. Others are very sensitive to changes in conditions and are intolerant of pollution. Ask students to think back to when they played *Macro-invertebrate Mayhem* at school. Each macro-invertebrate could tolerate different levels of pollution mainly due to their method of breathing.

Some macro-invertebrates are called "biologic indicator species" because they are used to evaluate water quality. If the macro-invertebrate population in a water body is very diverse, it is an indicator of good water quality. Refer back to them playing *Macro-invertebrate Mayhem* at school. The movement of mayflies, caddisflies and stoneflies was limited in the game because they are biologic indicator species.

Polluted water is often low in dissolved oxygen. If a body of water contains a large number of macro-invertebrate species that require high levels of dissolved oxygen are present, this is an indicator of good water quality.

Pass the *Pollution Index of Marsh* out to the students. Ask students to look over the categories: High Tolerance, Mid Tolerance and Low Tolerance. Ask students to explain these categories. Looking at the population of macroinvertebrates collected from the pond as the data, ask students the following questions:

- Of the macro invertebrates caught, which are considered to have Low Tolerance?
  (riffle beetles, caddisfly larvae, mayfly and stonefly nymphs, gill-breathing snails, hellgrammites)

- Of the macroinvertebrates caught, which are considered to have High Tolerance?
  (leeches, backswimmers, water boatman, aquatic worms, bloodworms, air breathing snails, mosquitoes)

- If macro-invertebrates that have High Tolerance to pollution are present, does this mean the water quality is bad? *No. Remember, highly tolerant species <u>can</u> and <u>do live everywhere</u>. The key is diversity. If highly tolerant macro-invertebrates are present in association with a variety of mid and low tolerant species, then the water quality is most likely good. If the only macro-invertebrates found were highly tolerant, then the water quality is most likely poor.*

- Once the class has their Water Quality Index score, is this pond considered to be healthy or unhealthy?

- What if you found very few macro-invertebrates in this wetland? Could a biologist assume this means the water is unhealthy? Could there be a reason for a lack of macro-invertebrates? *A biologist would never assume anything. If low levels of macro-invertebrates exist, a biologist would follow-up with additional testing.*

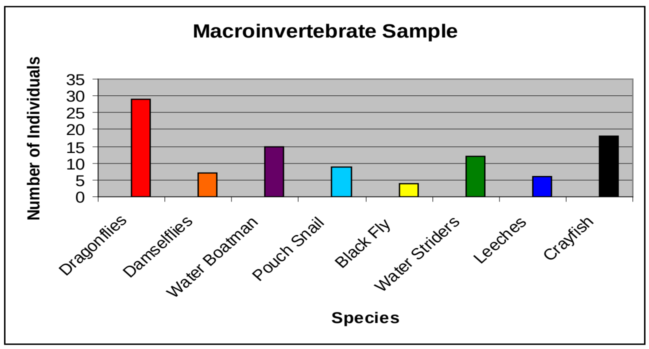
- What technique could a biologist use in place of a macro-invertebrate study to determine water quality? *In addition to macro-invertebrate sampling, biologists use chemical tests to study levels of dissolved oxygen, nitrogen, phosphorus, pH, water hardness, and alkalinity. Mechanical probes are also used to determine water clarity and temperature. Combining these methods would help biologists develop the most accurate picture of the health of a body of water.*

Data Analysis

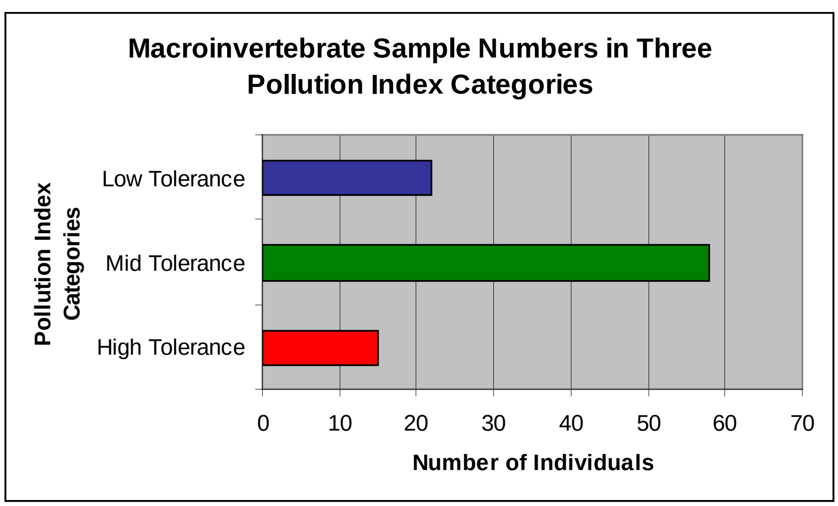
Inside the Visitor Center or Outside at Bass Ponds (15 minutes)

Back in the visitor center (or back at school if time is limited) analyze the data the students collected during this activity like a biologist would. Here are some possible representations.

- Help students consolidate individual group data into class data on the board or on a flip chart. Create a bar graph or pie chart comparing the numbers collected.



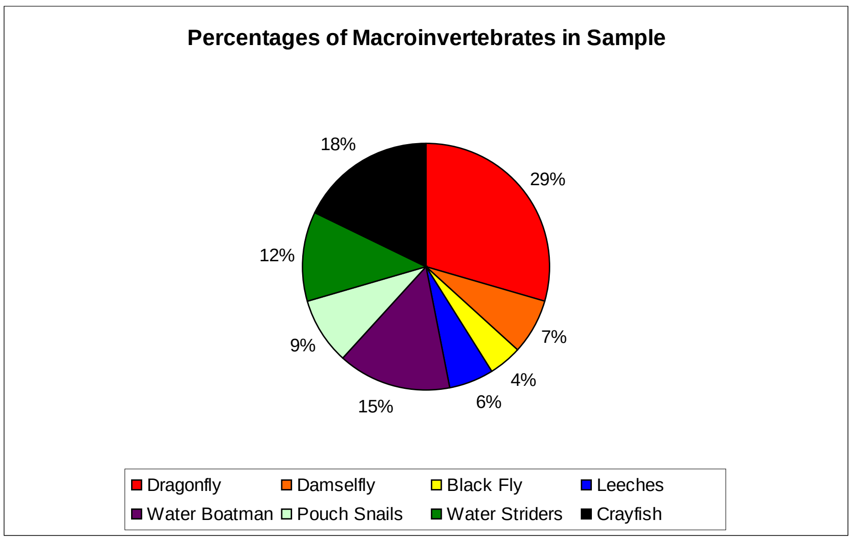
- Help students organize their data into the pollution index categories: High Tolerance, Mid Tolerance, and Low Tolerance. Graph the results. What does this data tell you about the relative health of this wetland?



- Help students analyze the percentages for each species of the total collected. For example, using the graph below, the percentage of dragonflies found in this sample was calculated using the following formula.

% Dragonfly Species (29%) = $\frac{\text{dragonfly individuals (29)}}{\text{total macro-invertebrates collected (100)}}$

Which type of macro-invertebrate represented was that largest portion of the sample?



Water Quality Hike

Skimmer and Hogback Ponds at Bass Ponds (10 minutes)

Hike with the students to the Skimmer Pond. Explain to the students that the Bass Ponds area is a natural filter for water coming from the top of the bluff as it moves downhill over roads, sidewalks, houses, apartments, businesses, and the Mall of America.

Once students arrive at Skimmer Pond they should notice garbage floating in the water, very little wildlife, and that the surface is completely covered with duckweed. When heavy rain falls in Bloomington, water runs down the bluff, to the Bass Ponds picking up trash and pollutants along the way. The first stop in the wetlands filtration system is the Skimmer Pond. Here, refuge staff and volunteers pick out the large pieces of trash.

Ask students if they remember from their classroom pre-activity how wetlands reduce the amount of harmful substances that enter a stream, river, pond, or lake. *Wetlands are like a strainer filtering contaminants like trash and contaminants such as fertilizers, oil, street salt, and street sand. Wetland plants neutralize harmful chemicals. Wetland soils trap and hold harmful particles giving bacteria and other microorganisms the chance to break them down.*

Walk students to the next pond in the filtration system; Hogback Pond. Do students notice the differences between the Skimmer and Hogback ponds? Hogback has less plant cover, no floating trash, and more wildlife.

Explain that the water moves through a series of ponds and is eventually released into Long Meadow Lake where wetland soils and plants continue to do their work. The water which flows into the Minnesota River is much cleaner than what first entered the Skimmer Pond.

Without wetlands, our waterways would look a lot like the Skimmer Pond, choked with plants and trash resulting ultimately in low water quality and poor wildlife habitat.

Water Canaries
Inside-Alternative

Materials

- Aquatic Investigation Kits-per student team of 2 or 3 that include: 4 specimen collection containers, 2 plastic spoons, laminated key to aquatic organisms, 2 magnifying glasses.
- Microscopes, petri dishes, well slides, droppers, paper towels, specimen observation dishes or white ice-cube trays, field guide / reference book.

a. Jug of tap water
b. Jug of pond water
c. 2 clear glasses
d. Poster-sized, laminated Water Quality Index Pond Data Sheet
e. Water Canaries Journal Page – one per student
f. Clipboards- 1 per student
g. Pencils- 1 per student
h. Calculators – 1 per team
i. Markers

Before the class arrives, collect pond water and pond life samples from a nearby pond (Courtyard Ponds or drive to Bass Ponds). Set up team specimen sampling stations in the classroom as you would outside but without the nets. Fill each tub with pond water and aquatic life.

Set up the field microscopes on a table away from the collecting stations. Place one plastic eye dropper and petri dish with each microscope. Place one well slide on each microscope stage.

<u>At the conclusion of the lesson</u>: Return live specimens to the wetland areas where they were collected. Be sure all microscopes and slide preparation materials are clean, dry and covered before storing. Thoroughly rinse equipment and leave out to dry in the visitor center classroom. Please inventory and note any low quantities of supplies or broken equipment.

Introduction

Ask students: How is a biologist able to tell if a body of water is "healthy?" Do you think biologists are able to tell if it is healthy just by looking at the body of water?

1. Pour some tap water (brought along in a jug) into a glass. Hold the glass up to show students the tap water. Ask students if they would feel comfortable drinking this water.
2. Fill a second glass with pond water (brought along in a jug). Ask students if they would feel comfortable drinking this water.
3. Which of the two types of water would be "healthier" for a minnow or insect larvae?

Explain to students the terms "clean" and "healthy" have different meanings. Pond water may not be fit for humans to drink; however, many of the small organisms seen floating in the water may be food for a multitude of other creatures living in the water. Most pond life would die if left too long in sterile drinking water.

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Divide the class into teams. Assign each team to one sampling station. Remind students that all plants and wildlife that live in a wetland depend on water for survival. It's important to always have pond creatures and the plants in water, whether it's a petri dish, ice cube tray, or bowl. Show the students how to collect creatures from the water using a plastic spoon.

Sorting and Identification

(30 minutes)

Explain that students will rotate through the stations with about 10 minutes at each one. Pass out a journal page, clipboard and pencil to each student. Instruct them to "sample" their site in the following way:

1. Sort the animals into similar groups. For example, sort all the dragonfly larvae into one container, all leeches into another and so on.

2. Now identify and record the number (used only in the data analysis component of this activity) of each different species of macro-invertebrate on the journal page.

3. BEFORE moving to the next station, return all the organisms back to the sampling bin.

Bring out the laminated, poster-sized *Water Quality Index* datasheet and pass out 2 calculators to each team. Work through the data sheet as an entire class. Complete the calculations by following the directions at the top of the sheet. Ask students to use the calculators to help determine the water quality score.

Data Analysis

Refer to the original section for directions on how to graph and interpret data for this activity.

Wrap-up Management Connection

Using a Biotic Index to Predict Water Quality

(15 minutes)

Refer to the original section for the discussion and the directed questions.

Water Quality Index

Pond Data Sheet

(To be done as an entire class led by refuge staff)

1. Place an X next to the invertebrates that you have collected.
2. Add up the number of macro-invertebrates found in each group. Multiply the number by the group's weighting factor. This gives you the GROUP SCORE.
3. Add up all the group scores for the TOTAL GROUP SCORE.
4. Add up the # in each group for the TOTAL NUMBER of GROUPS.
5. Divide the total group score (from step 4) by the total number of groups (from step 2). This will give you the WATER QUALITY INDEX for the pond.
6. Using the table (bottom right of the page) circle the pond's water quality index.

	Group 1 Intolerant to pollution	Group 2 Moderately tolerant to pollution	Group 3 Fairly tolerant to pollution	Group 4 Very tolerant to pollution
Macroinvertebrates (record the total number of each species you found)	Alderfly _____ Dobsonfly _____ Stonefly _____ Snipe Fly _____	Caddisfly _____ Clam/Mussel _____ Cranefly _____ Crayfish _____ Damselfly _____ Dragonfly _____ Mayfly _____ Riffle Beetle _____ Whirligig Beetle _____	Black Fly _____ Midge _____ Gilled Snail _____ Scud _____ Water Scorpion _____ Crayfish _____ Fingernail Clam _____ Water Strider _____ Water Mite _____	Aquatic Worm _____ Blood Worm _____ Leech _____ Pouch Snail _____ Mosquito Larva _____ (or Pupa) Water boatman _____ Backswimmer _____
# in each Group (in each group)	(f)	(g)	(h)	(i)
Weighting Factor	x 1	x 2	x 3	x 4
Group Score (Species x weighting factor)	= ______(a)	= ______(b)	= ______(c)	= ______(d)

Total Group Score	(a)+ (b) + (c) + (d)	(e)
Total Number of Groups	(f) + (g) + (h) + (i)	(j)
WATER QUALITY INDEX (e) / (j)		

Water Quality Index
(circle one)

Excellent	1.0 – 2.0
Good	2.1 – 2.5
Fair	2.6 – 3.5
Poor	Greater than 3.5